Chapter X
Wireless Peer-to-Peer Media Streaming: Incentives and Resource Management Issues

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ABSTRACT

The widespread deployment of competing wireless technologies has created new research opportunities. In particular, the authors consider media streaming in hybrid wireless networks where each mobile device is equipped with two wireless network interfaces: server interface and peer interface. The server interface connects wireless clients to the server while the peer interface allows neighboring clients to communicate with one another. The two interfaces have different energy characteristics. In this chapter, the authors first give a brief account of P2P media streaming in wireless operating environments. They then survey and analyze the current state-of-the-art in tackling the security and performance issues in P2P media streaming systems. In view of the deficiencies of the existing approaches, they introduce new approaches based on game theoretic concepts. Specifically, the authors propose two collaborating relationships in which neighboring clients utilize both interfaces to share the energy cost of retrieving media content from the server. Their results show that the proposed relationships improve the streaming performance of peers without violating their energy consumption constraints. Moreover, both relationships are stable when clients neither unilaterally deviate nor voluntarily leave as a group.
INTRODUCTION

With the prevalence of wired and wireless broadband Internet connections, we are no longer bound to traditional applications such as browsing the web, checking emails, text messaging, etc. There has been a rapid growth of bandwidth-intensive applications in both wired and wireless networks (Erman et al., 2007; Henderson, Kotz & Abyzov, 2004; Khan & Ahmad, 2006; Li, 2006; Jazayeri, 2007; Sen & Wang, 2004; Wen, Longshe & Qiang, 2006). One of the most prominent examples is streaming multimedia content, or media streaming. Specifically, media streaming refers to the simultaneous distribution of multimedia content from a provider to a group of users. We begin with illustrating the following scenario. Consider a class of students attending a lecture on campus. The lecture is also being broadcast on the Internet so that students can watch the visual aids and listen to instructions while staying at home. At the same time, other students can subscribe to that broadcast event through their mobile devices on the way to campus.

We note that the same scenario is also applicable to a variety of contexts, such as delivery of radio programmes, TV dramas, football matches, etc. This illustrates the tremendous potentials of media streaming. In a typical media streaming application, the media provider only employs a limited number of media servers to distribute the media content, which is usually a combination of audio and video information. On the other hand, each streaming session may consist of a dramatic number of simultaneous users, ranging from tens to hundreds of thousands or more. How could the media provider achieve such scalability while still remain cost effective?

In this chapter, we first give a brief account of P2P (Peer-to-Peer) media streaming in wireless operating environments in the Media Streaming in Hybrid Wireless Networks section. We then survey and analyze the current state-of-the-art in tackling the security and performance issues in P2P media streaming systems in the State-of-the-Art Incentive Mechanisms for P2P Media Streaming section. The System Model of Media Streaming in Hybrid Wireless Networks section describes the system model, and in view of the deficiencies of existing approaches, we introduce our proposed approaches to P2P media streaming based on game theoretic concepts, for which we provide some basic background in the Game Theory - Mathematical Analysis of Conflicts section. In the Analysis of Proposed Collaborative Media Streaming section, we propose and analyze two collaborating relationships in which neighboring clients utilize both interfaces to share the energy cost of retrieving media content from the server. This is followed by a detailed explanation of the proposed protocols in the Proposed Collaborative Media Streaming Protocols section. Our results in the Performance Evaluation section show that the proposed relationships improve the streaming performance of peers without violating their energy consumption constraints. Moreover, both relationships are stable when clients neither unilaterally deviate nor voluntarily leave as a group. Finally, we suggest some future research directions and conclude the chapter.

MEDIA STREAMING IN HYBRID WIRELESS NETWORKS

Traditionally, wireless networks have been dominated by voice traffic. The advancement of various wireless technologies has fostered a wide range of data-oriented applications. One of the most popular applications is on-demand wireless data access (Barbara & Imielinski, 1994; Cao, 2002; Cao, 2003; Yeung & Kwok, 2005a; 2005b; 2006a; 2006b; Yin & Cao, 2006), which enables users to query data objects kept at a remote server using their mobile devices. Another emerging wireless application is to deliver high quality media content to heterogeneous mobile devices (Andronache et al., 2006; Debnath, Cranley & Davis, 2006;